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PAPER/PLASTIC LAMINATE AND METHOD FOR MAKING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part application of a prior application Serial No: 09/867,293 filed on May 29, 2001 entitled "Paper/Plastic Laminate and Method for Making Same", which is incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention is generally directed to paper. More particularly the invention is a paper/plastic laminate that can withstand elevated temperatures such as are encountered in office, midrange and high-speed traditional laser and digital copiers and digital printers, and other like equipment using heat set fuser toner adhesion as the method for fusing/bonding an ink to a paper.

BACKGROUND OF THE INVENTION

[0003] Durable papers are designed to perform in environments unfriendly to regular papers, such as the generally available 100 percent fiber papers. There are four basic categories of durable papers: papers that are bulkier or in some other way stronger; papers that have been surface treated; synthetic papers; and paper/plastic laminates.

[0004] Generally, paper/plastic laminates are composed of a paper web affixed to a plastic film. These paper/plastic laminates have tear characteristics comparable to synthetic papers and surface characteristics comparable to regular paper. Beyond the tear resistance of paper/plastic laminates, the paper web can be manipulated by well known methods to give the paper surface characteristics suitable for a broad range of applications such as fine writing papers, maps or archival documents. Current paper/plastic laminates, however, suffer from an inability to be used effectively with office, midrange and high-speed traditional laser and digital copiers and digital printers, and other like equipment using heat set fuser toner adhesion as the method for fusing/bonding an ink to a paper. Current paper/plastic laminates do not work well with this equipment as the equipment employs processes during normal operation that reach temperatures at which the paper/plastic laminate loses dimensional stability, which is manifested in wrinkling and curling of the paper/plastic laminate.

[0005] The dimensional instability of current paper/plastic laminates results from the laminating method employed to bind the paper web to the plastic film. Many current laminating processes employ fluids, water or solvent, that must be removed from the laminated product by heating, or other known methods. This heating alters the characteristics of the laminate, paper web and/or plastic film, leading to the dimensional instability when the conventional equipment reheats the paper/plastic laminate. The heating process also complicates and adds cost to the manufacturing process, due to the need for additional equipment such as ovens and pollution controls, and the increased time required for manufacture.

[0006] A further problem associated with the use of fluids in manufacturing paper/plastic laminates is the limitations on the overall basis weight of the paper web. The paper web must have sufficient strength to be capable of being processed while wet. The basis weight and caliper of the paper web is, therefore, increased to assure an appropriate paper web wet strength. This leads to paper/plastic laminates that have a caliper, thus weight, greater than would otherwise have been required if fluids were not used.

[0007] A further problem associated with paper in general, and business documents in particular, is counterfeiting. Major problems have surfaced because of fraudulently produced currency, checks, election ballots, wills, legal papers, coupons, gift certificates, insurance papers, stock certificates, packaging, prescription pads and other documents is a major problem. Document fraud costs corporations, financial institutions, government agencies and individuals billions of dollars per year. Everyone therefore has the need to protect against illegal copying and adulteration of documents. In each case the security of each document depends mainly on the paper.

[0008] Current technology can provide almost anyone the tools necessary to fraudulently duplicate and manipulate paper documents. In addition to physical tampering, color copiers, personal computers and scanners are now used extensively by counterfeiters to easily duplicate original documents.

[0009] As a result various types of security papers have been developed to help mitigate the problem. Security paper is paper that has been engineered and manufactured to incorporate physical features imbedded in the paper itself to resist document forgery and the copying of original documents. The paper is fully compliant with the physical paper standards of weight, grain direction, moisture content, etc., but has additional "chemical and fiber" fraud resistant features built into the paper during the manufacturing process. The features themselves cannot be readily copied or reproduced via conventional reproduction processes.

[0010] Various techniques are used to produce security features in paper. There are "active" features, which are used to identify an original document by sight or touch and "passive" features, which become apparent when a document is photocopied or scanned. Additional action is required to activate this feature. Examples of active features are colored fibers in the paper, watermarks, optical holograms, micro printing, and security backgrounds. Passive features include invisible fluorescent fibers that can only be seen under UV backlight, words such as "void" or "unauthorized copy" appear on copy when a document is photocopied or scanned and chemically reactive paper. All of these features are intended to help

prevent unauthorized document duplication and are all features that are incorporated into the paper.

[0011] Therefore, it would be beneficial if a tear-resistant paper/plastic laminate could be developed that can overcome the various known problems associated with document security.

SUMMARY OF THE INVENTION

[0012] The invention is a paper/plastic laminate that includes a paper web having a bottom surface and a plastic film having a top surface. At least the top surface of the plastic film includes a printed image. The bottom surface of the paper web is laminated to the top surface of the plastic film over the printed image using a 100 percent solids, or solventless, adhesive.

[0013] According to one aspect of the present invention, a second paper web is laminated to a bottom surface of the plastic film. The bottom surface of the plastic laminate may also include a printed image.

[0014] A 100 percent solids, or solventless, adhesive as used herein means an adhesive employing 100% Solids Adhesives technology as differentiated from solvated adhesives and waterborne adhesives. The solventless adhesive used is one that remains dimensionally stable in equipment employing heat set fuser toner adhesion as the method for fusing/binding the ink to the paper. Depending upon the desired application for the paper/plastic laminate, the paper web and the plastic film can have a range of characteristics.

[0015] The paper web has a top surface that permits writing or printing to be placed thereon using conventional writing implements, printing equipment and inks, and it is adapted to permit the paper/plastic laminate to be used with the equipment identified above. The characteristics of the paper web can be tailored, similarly to regular paper, to the application by any of a number of conventional processes well known to those skilled in the art of papermaking. Characteristics

commonly adjusted are dimensional stability in the presence of heat, opacity, brightness, pH, water resistance, and acid content. The paper web, however, must be formulated to be compatible with the plastic film and the laminating process discussed below. In the laminating process an adhesive is applied between the paper web and the plastic film; therefore, the paper web must be formulated to avoid such problems as excess adhesive penetration and holdout.

[0016] The plastic film can be of any material to which the paper web can be adhered. The most common plastic film materials are polyester and polypropylene. The plastic film material is selected not only for its ability to be adhered to the paper web, but also for its dimensional stability, both shrinkage and distortion, in the presence of heat. The processes used in the conventional equipment mentioned above can generate significant heat, up to at least 375 degrees F. This heat is sufficient to curl and/or to shrink current paper/plastic laminates. Therefore, the plastic film is selected not only for its strength, but also for its thermal characteristics.

[0017] The laminating process positions an adhesive between the paper and the plastic film and then laminates, compresses, the paper to the plastic film. The adhesive used is a 100% solids, or solventless, adhesive that is designed to resist thermal breakdown at application temperatures.

[0018] The resulting paper/plastic laminate is dimensionally stable allowing for traditional imaging applications and processing of all forms of printing, heat set toner fusing, ink-jet printing and high-speed paper converting. Dimensionally stable meaning that the paper/plastic laminate remains essentially flat, no curl or stretch, when passed through conventional paper utilizing machines using heat set fuser toner adhesion, for example copiers such as a Docutech 6180 by Xerox and Heidelberg 9110 Digimaster, digital printers and laser printers wherein fusing temperatures are greater than about 375 degrees F.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Fig. 1 is an enlarged perspective view of the paper/plastic laminate of the present invention with a cutaway portion that reveals an image printed on the plastic laminate.

DETAILED DESCRIPTION

[0020] As shown in Fig. 1 a paper/plastic laminate embodying the present invention, generally referred to by the reference number 10, includes a paper web 12 and a plastic film 14. The paper web 12 has a top surface16 and a bottom surface 18. The plastic film 14 has a top surface 20 and a bottom surface 22. The bottom surface 18 of the paper web 12 is secured to the top surface 20 of the plastic film 14 by an adhesive layer 24. In this embodiment, a second paper web 26 having a top surface 28 and a bottom surface 30 has the top surface 28 adhered to the bottom surface 22 of the plastic film 14. A laminating process, discussed *infra*, adheres the paper web 12,26 to the plastic film 14.

[0021] The paper web 12 is designed to have suitable characteristics for application in office, midrange and high-speed traditional laser and digital copiers and digital printers, and other like equipment using heat set fuser toner adhesion as the method for fusing/bonding an ink to a paper. A paper web 12 ideally suited for these applications will be one that can withstand the temperature extremes of the process while maintaining its dimensional properties.

[0022] The paper web 12 is comprised of a fibrous web formulated with a blend of softwood Kraft, hardwood Kraft and/or recycled fiber. Brightness is a function of the application. A GE brightness value in excess of 83, per TAPPI test method T 452 om-92, is preferred for general writing paper. In premium writing paper, the GE brightness should be around 95, or higher. Conventional optical brightening additives can be used to achieve the desired level of brightness. As those skilled in the art of papermaking will appreciate, selection of the components of the fibrous web affects the brightness of the paper.

[0023] The filler content in the paper web must be suitable to provide the opacity desired. For general paper applications, an opacity of at least about 77 percent is suitable, but a minimum opacity of 79 percent is desired. Caliper of the paper web is determined by the application of the paper/plastic laminate and the laminating equipment.

[0024] In certain applications water resistance as well as wet strength may be desired. Water resistance can be achieved by use of a conventional internal sizing additive. A conventional wet strength additive may also be incorporated to increase wet rub resistance. Sizing methods and the amount of sizing, as well as wet strength additives are well understood in the art.

[0025] To be used in office, midrange and high-speed traditional laser and digital copiers and digital printers, and other like equipment using heat set fuser toner adhesion as the method for fusing/bonding an ink to a paper, the paper must have an electrostatic level of between approximately $10^9 - 10^{12}$ SER (Surface Electrical Resistivity). This level of SER can be achieved by surface treating the top surface 16, 30 with a metal salt such as sodium salt and more specifically sodium nitrate or sodium chloride. The in present invention the paper web was treated with sodium nitrate at the rate of 50 pounds per 1000 pounds of starch, a rate approximately 30 percent greater than typical treatments for standard xerographic paper.

[0026] The paper web 12 must be formulated to maintain dimensional stability in the extreme operating temperatures found in heat set fuser toner adhesion. To control curl and shrinkage, it is important that the overall moisture content of the paper web be in the range of about 4 to 5 percent. The paper web 12 must also be resistant to adhesive penetration and allow sufficient holdout (the laminating adhesive is discussed below). Adhesive penetration and paper holdout should be balanced to allow maximum surface contact, or wetting out. A sufficient level of surface sizing or coating applied through any of several conventional techniques can be used to minimize the penetration of the adhesive into the paper

web 12. Conventional sizing or coatings can be used such as starch, PVA or Latex. AKD (Alkyl Ketene Dimer) sizing in combination with starch sizing has been found to provide suitable adhesion penetration and holdout for a non-acid paper web 12.

[0027] The plastic film 14 can be of any material; however, common plastic film materials include, but are not limited to, polyester or polypropylene. The key factors in the selection of plastic film 14 material include dimensional stability, low shrinkage, balance, and heat resistance. An ability to adhere to the paper web is important, as well. Plastic film 14 properties generally vary by material gauge. Present plastic films 14 employed in the manufacture of paper/plastic laminates of 27-lb. (500 sheets, 17 inch by 22 inch sheets) have gauges of about 118 (approx. 30 micron).

[0028] In general, the plastic film 14 should have a mechanical strength exceeding about 29,000 psi, approximately 20.4 Kg/mm^2, in all directions measured using ASTM D 882. Thermal heat shrinkage should be less than about 2 percent using the SKC Method (this is an internal measurement of SKC, Inc. of Covington, GA), 150 degrees C for 30 minutes.

[0029] The top surface 20 of the plastic film 14 includes at least one printed image 32, as shown in FIG. 1. The printed image 32 may include one or more colors and be of any desired design. Typically methods for applying a printed image onto a plastic film include, but are not limited to, Gravure, Flexographic, Letter Press, or Direct Type processes. In some embodiments, printed images may be applied to the plastic film by ink jet, or laser, printing, as well. Suitable inks for printing the image include, but are not limited to, solvent or water-based inks, acrylic inks and ultra-violet ("UV") inks. In some embodiments, especially those including a second paper web 26 adhered to the bottom surface 22 of the plastic film 14, may include a second printed image 34 on the bottom surface 22 of the plastic film. The second printed image 34 may be applied in the same, or different, manner as the printed image 32 on the top surface 20. Preferably, each printed image 32,34 is visible through the paper web 12,26 once the laminating process, discussed *infra*, is complete.

[0030] The laminating process used to adhere the paper web 12,26 to the plastic film 14 uses a 100 percent solids adhesive. The laminating process produces a destructive bond between the paper web 12,26 and the plastic film 14. A destructive bond is defined as a bond between the paper web 12,26 and the plastic film 14 that after curing under a T Peel Adhesion Test will not allow the paper web 12,26 to be separated from the plastic film 14 with the paper web 12,26 remaining intact.

[0031] The 100% Solids, or solventless, Adhesive used in the present invention is a low temperature (flowable at room temperature at about 100 degrees F) two-component adhesive or a warm (gel at room temperature that is heated to permit the adhesive to flow) one-component adhesive. The selection of adhesive is based on the adhesive penetration and holdout characteristics of the paper web. Generally, the warm temperature adhesive is used where the adhesive penetration and the holdout of the paper web is a concern. The low temperature adhesive is used when adhesive penetration and holdout of the paper web are less of an issue. Each adhesive properly used should produce the desired destructive bond.

[0032] Lamination is accomplished using standard lamination techniques. The adhesive can be applied directly to the paper web and/or the plastic film prior to lamination. While the adhesive might be heated to enhance its flow characteristics, the paper web and the plastic film are not heated, except incidentally by contact with the warmed adhesive, if any. The adhesive cures without the addition of heat. Where a second paper web is to be laminated to the other side of the plastic film, some curing time for the first bond should be allowed for.

[0033] Example 1

[0034] A 27-lb. paper/plastic laminate meeting the requirements of the present invention can be made as follows. Obtain 32 GSM SUPERWHITE Laminating Base from ESLEECK of Turners Falls, MA. Obtain 118 gauge plastic film designated SR50 Skyrol® Polyester from SKC, Inc. of Covington, GA. The paper

web is then laminated to the plastic film by process L1230 of Chase & Sons of Randolph, MA. The specification of the process will specify the 100% Solids, or solventless, adhesive, and its method of application to the paper web and/or plastic film.

[0035] In operation, and as described above, the plastic film 14 is embedded between either one or two layers of the paper web 12,26 and, therefore, the printed image 32,34 is protected. As a result, the plastic film 14 having a printed image 32,34 thereon is not accessible to be altered without destroying the paper/plastic laminate 10. In addition, the differences between the original paper/plastic laminate 10 and a typical photocopy or digital scan is evident to the naked eye. Therefore, a document having security features can be created without alterations or special features being added to the paper.

[0036] Although the present invention has been described in considerable detail with reference to certain preferred versions thereof, other versions are possible. Therefore, the spirit and scope should not be limited to the description of the preferred versions contained herein.